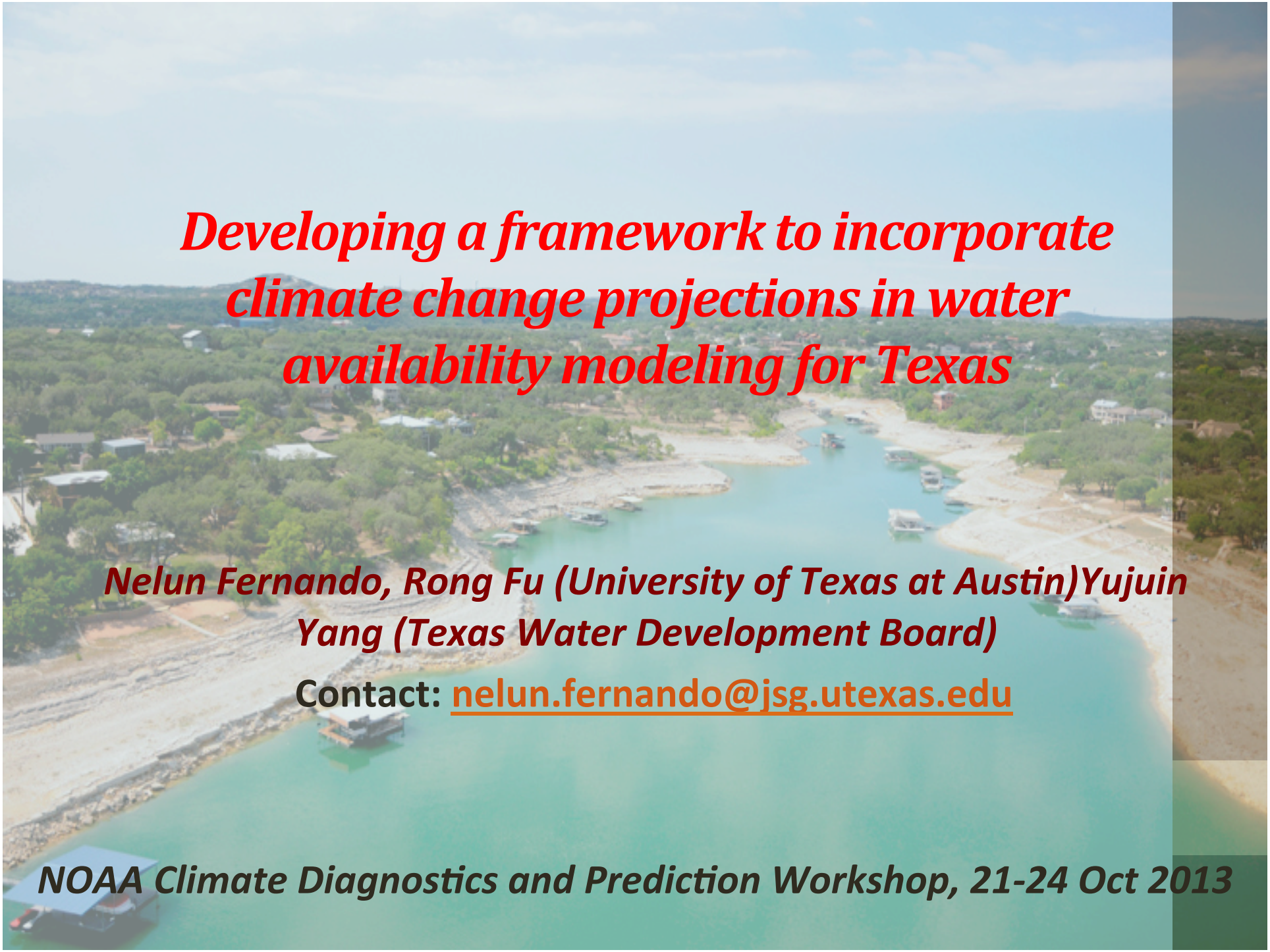

Developing a framework to incorporate climate change projections in water availability modeling for Texas

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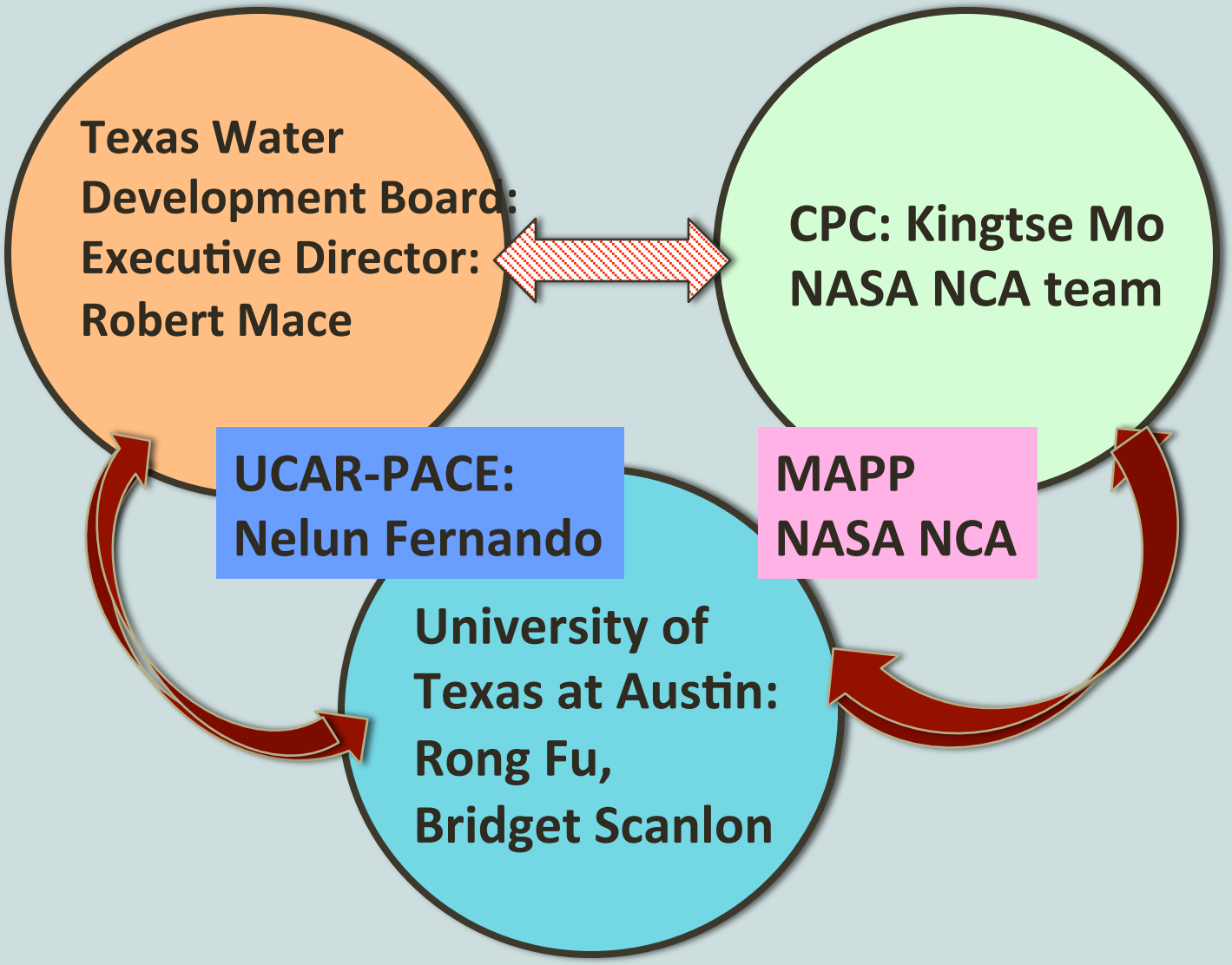
NOAA Climate Diagnostics and Prediction Workshop, 21-24 Oct 2013

Applying climate information to support decision making:



Water planning and drought management in Texas

Long-term planning:

- Texas legislature requires the TWDB to develop a water plan addressing water needs 50 years into the future to address irrigation, municipal, livestock, mining and energy needs, updated every 5 years
- Water is supplied to users based on “water rights”. Water planning is based on being able to ensure that all allocated water rights can be met given a recurrence of the 1950s drought- of-record.

Short-term Drought management:

- Provide drought information to the state drought preparedness council

Research Tailored to the needs of TWDB:

- **Develop a summer drought early warning indicator to support drought management though the state drought preparedness council**

- **Explore use of climate information for water long-term planning (-2050)**

Rationale for an observational-process based summer drought early warning indicator?

- **Climate predictions are more reliable during winter and early spring, than during late spring and summer (e.g., Guan et al. 2012).**

- **Observation and processes study: All the severe-to-extreme summer droughts over the SC US are linked to dry spring, only two dry springs are not followed by dry summer (Fernando et al. 2013).**

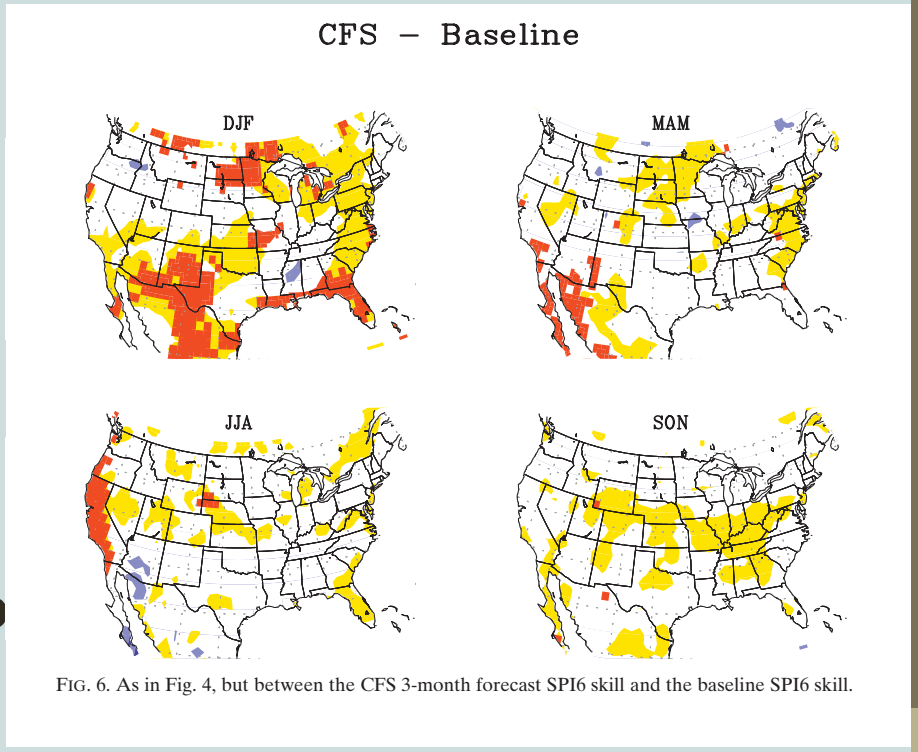
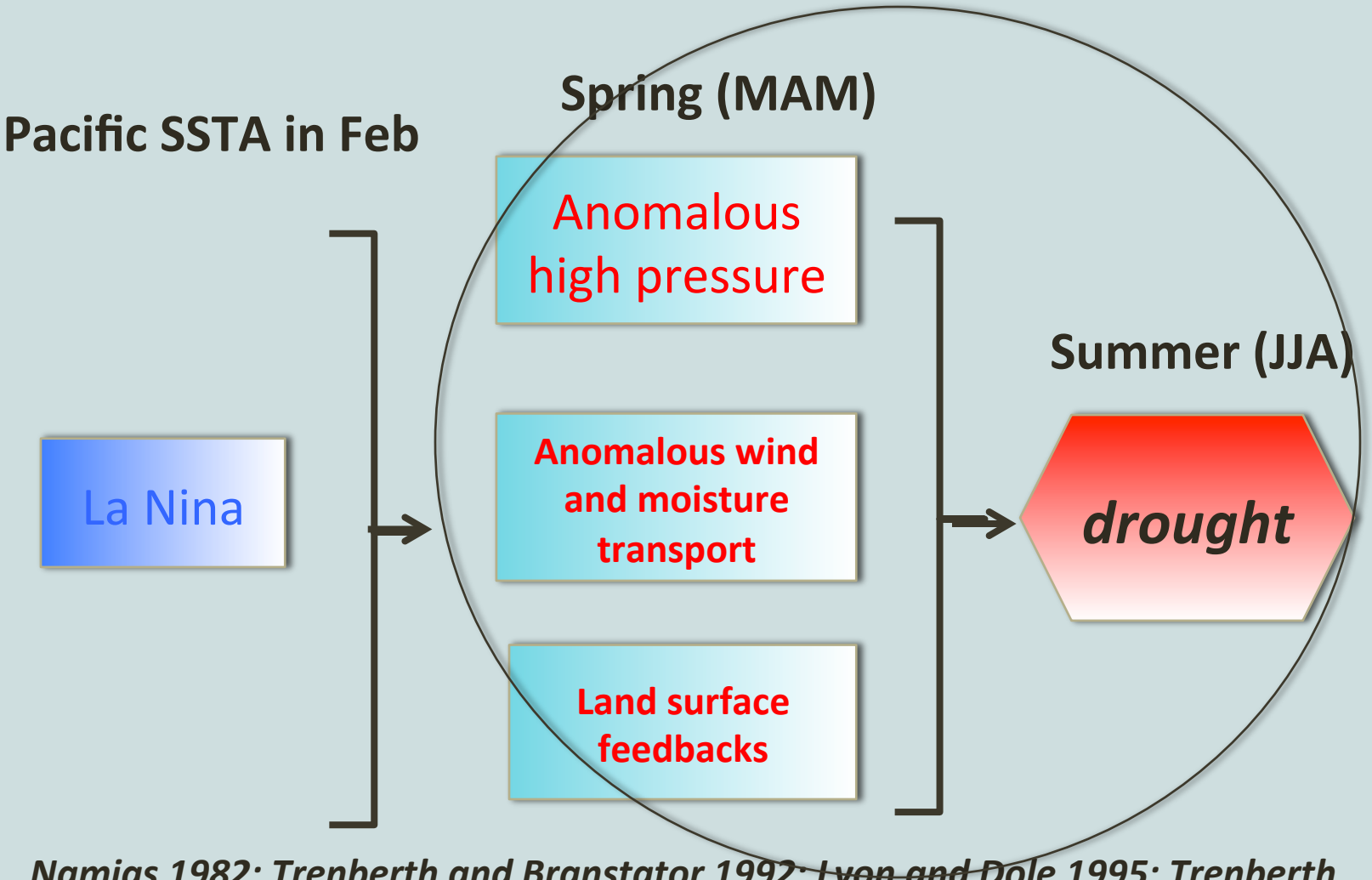


FIG. 6. As in Fig. 4, but between the CFS 3-month forecast SPI6 skill and the baseline SPI6 skill.

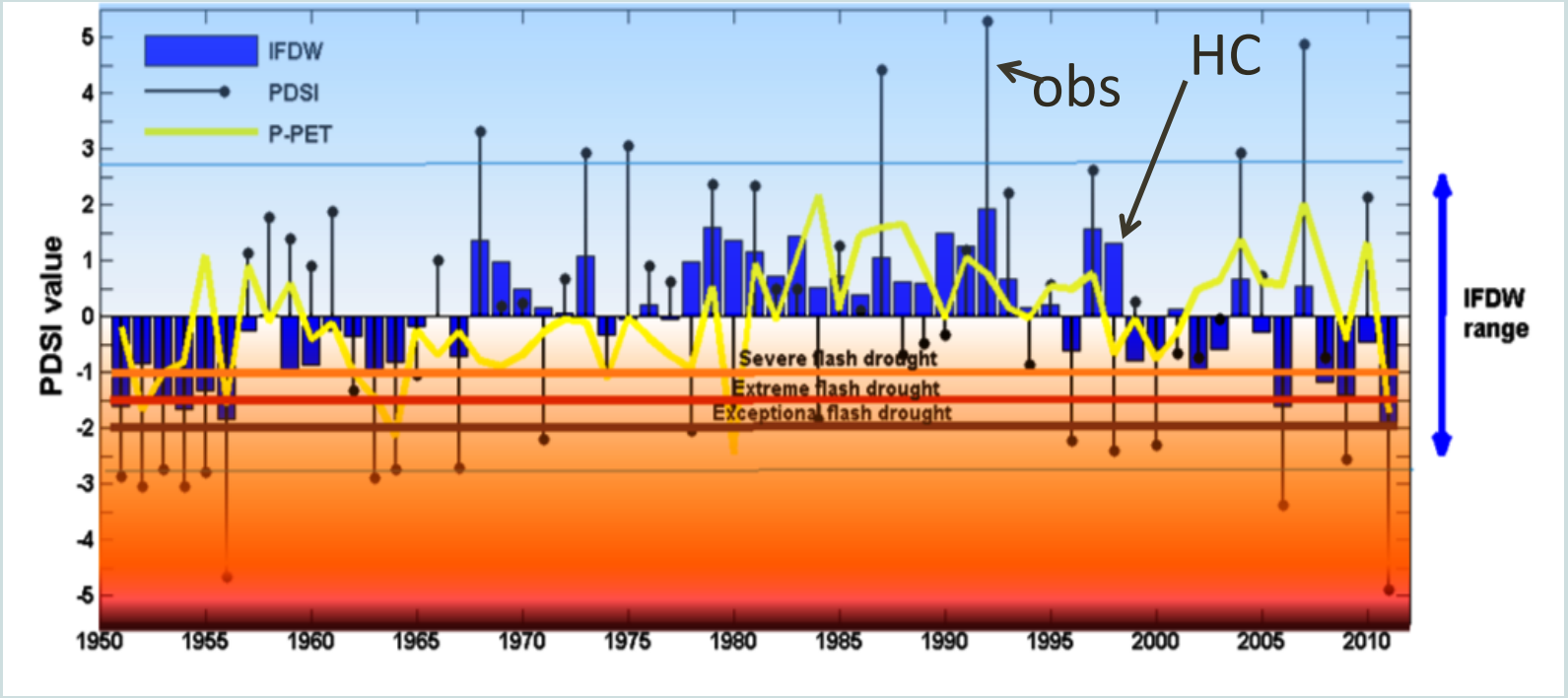
Guan et al. 2012:

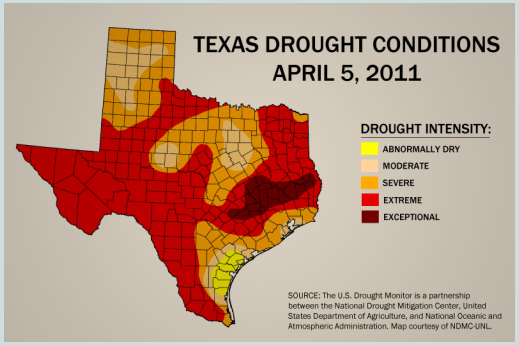
Using climate information in winter and spring to assess risk of summer drought



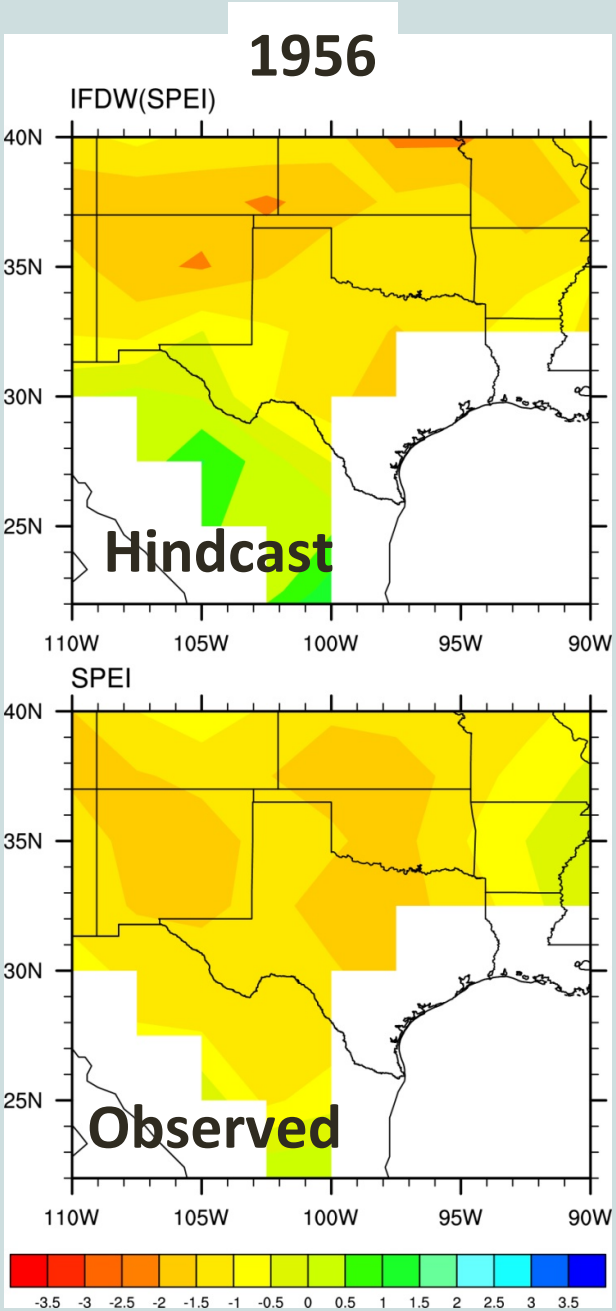
Namias 1982; Trenberth and Branstator 1992; Lyon and Dole 1995; Trenberth and Cuillemot 1996, Myoung and Nielsen-Gammon 2010

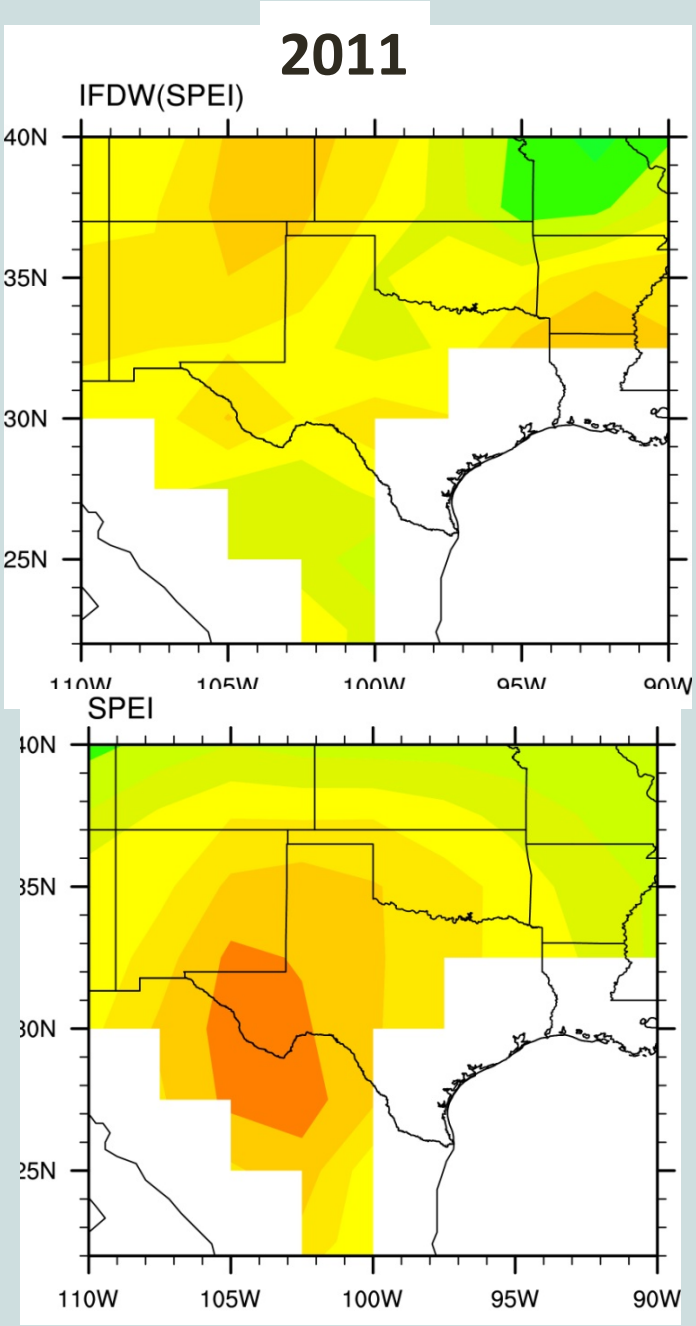
Prototype Hindcast (1951-2011):





SPEI6


1956
IFDW(SPEI)
40N
35N
30N
25N
Hindcast
110W
105W
100W
95W
90W
SPEI
Observed
-3.5 -3 -2.5 -2 -1.5 -1 -0.5 0 0.5 1 1.5 2 2.5 3 3.5


2011
IFDW(SPEI)
40N
35N
30N
25N
110W
105W
100W
95W
90W
SPEI

Summary-1

- A prototype process-based statistical model demonstrates the potential for an early warning indicator for severe to extreme summer drought using anomalous climate conditions in spring.
  - Need to understand underlying processes that could provide memory
  - Need to assess potential improvement and limitations of this summer drought early warning indicator

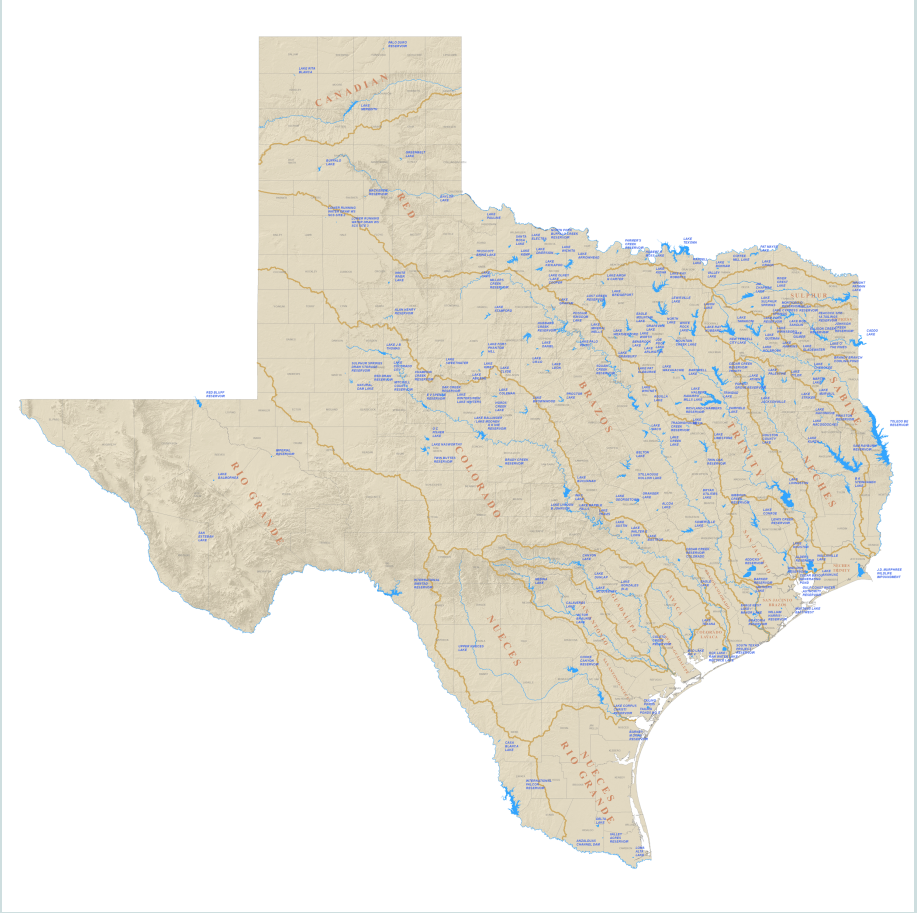
Support State long-term water planning:

Surface water supply

- 176 reservoirs in the state representing 70% of surface water supply

- **How might climate change affect the sensitivity of reservoir firm yield?**

Firm yield: Water available in a reservoir to meet all mandated water needs during a drought-of-record



Reservoir firm yield estimation with WAM models

- Water Availability Models (WAM) are used for planning

WAM input variables

- Naturalized flow in 14 river basins in Texas
- Net evaporation
- Existing water rights on the basins

How can future climate scenarios be incorporated?

Background

1. Information on future climate is not incorporated in the planning process
2. Would use of future climate projection make difference in water planning?

Framework

1. Explore empirical relationship between naturalized flow at outflow station in basin and precipitation
2. Explore empirical relationship between pan evaporation and potential evaporation

Framework applied to the Brazos

Datasets used

- Quadrangle precipitation and pan evaporation from the Texas Water Development Board http://www.twdb.texas.gov/surfacewater/rivers/reservoirs/img/lakes_lrg.gif
- Naturalized flow at the outflow station of the Brazos
- Aggregate data to annual time step

Naturalized flow and precipitation

Regression based on data:

- Naturalized flow = β (precipitation)
- β = 31.7655, Confidence interval = [28.8014 , 34.7295]

- Pan evaporation = β (PET)
- β = 0.3789, Confidence interval = [0.3694 , 0.3883]

Obtain % change in mean evaporation and naturalized flow for the period 2021-2050 versus 1971-2000

- Example with CCSM4 under the RCP 8.5 scenario:
  Decrease of naturalized flow: 4.8%
  Decrease of net evaporation: 10.7%

Next steps

Evaluate and correct biases in climate projections:

- **Connected to our MAPP CMIP5 project**
- **Using multi-model ensemble and most-likely projection**

Use WAM to assess the influence of future climate changes on the adjusted naturalized flow and evaporation and water infrastructure planning.

- **Run WAM model adjusting naturalized flow and evaporation by the % changes for 2021-2050**
- **Assess the sensitivity of firm yield to future precipitation and evaporation**
- **Carry out the analysis for the remaining 13 basins.**

Summary:

- ***Applying the latest research results of drought and climate research to support short-term drought management and long-term water planning can be fruitful.***

- ***Long-term partnership, trust and research tailored to the needs of policy maker are essential***

- ***Combined UCAR-PACE postdoctoral program and MAPP project played a crucial role in making collaboration with state agency possible.***